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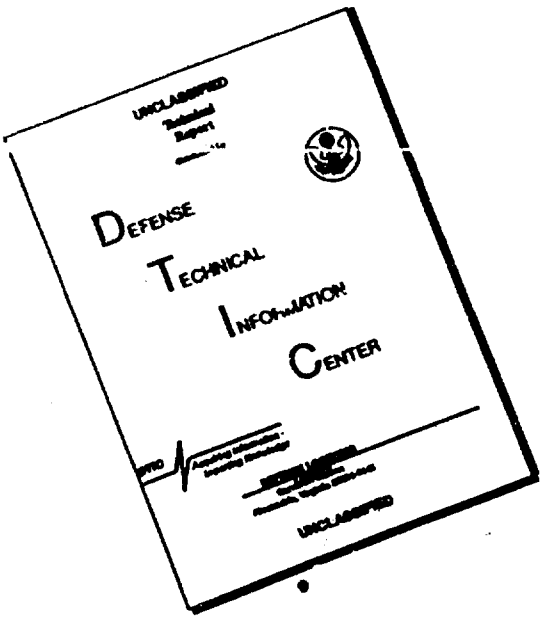


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# Diarrheal and Respiratory Disease Aboard the Hospital Ship, USNS *Mercy* T-AH 19, during Operation Desert Shield

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**Diarrhea and respiratory disease were common problems among ground troops deployed to the Middle East during Operation Desert Shield. In order to determine the prevalence and impact of diarrheal and upper respiratory disease among shipboard personnel during this period, an epidemiologic survey was conducted on the hospital ship, USNS *Mercy* T-AH 19. An episode of acute diarrhea was reported by 46% of the surveyed population, and 79% reported upper respiratory symptoms. Six percent of personnel were temporarily unable to perform scheduled duties due to gastrointestional symptoms and 7% due to respiratory symptoms. Officers were at increased risk of experiencing an episode of diarrhea, and female crew members more often reported respiratory complaints. Improved strategies to prevent diarrhea and respiratory disease among shipboard personnel are needed.**

## Introduction

Historically, infectious diseases have had a profound impact on U.S. military operations during both war and peacetime operations.[1-3] In World War II, 85% of hospital admissions were for medical conditions, and of these, 20% were for infectious diseases.[4] Military operations in the Middle East during World War II, and more recently joint American-Egyptian exercises, have been affected by a high incidence of infectious diarrhea.[2,5] Infectious diarrhea and respiratory illness have also accounted for a significant number of lost personnel-days among U.S. troops deployed during peacetime, including those aboard naval ships making port visits in the Middle East.[6-9] Diarrheal and respiratory disease were again major problems for ground troops during Operation Desert Shield.[10,11] However, the extent of infectious disease problems among shipboard personnel during the war with Iraq has not been previously reported.

The USNS *Mercy* T-AH 19 is one of two 1,000-bed hospital ships which deployed to the Persian Gulf during Operations Desert Shield and Desert Storm. The USNS *Mercy* T-AH 19 left Oakland, California, in early August 1990, and remained in the Middle East theater of operations until April 1991. The ship carried an initial crew of approximately 870 military personnel and 65 civilian Military Sealift Command personnel. The crew was augmented by activated naval reservists to approximately 1,200 military personnel in early January 1991. Ship operations consisted primarily of alternating 4-week periods of anchorage in the Persian Gulf, 20 miles off Bahrain, and active steaming in the North Arabian Sea. There was a brief port visit at Subic Bay, Philippines, in September 1990, during the initial transit, and subsequent port visits to Bahrain, Dubai, and Saudi Arabia while on station in the Persian Gulf. During Operation Desert Shield, the ship functioned as a referral hospital for patients from other ships in the area and ground-based medical facilities.

During deployment, a significant number of the crew experienced diarrhea and respiratory symptoms, in many cases affecting service members' ability to perform their duties. To assess the prevalence and impact of diarrheal and respiratory illness aboard ship in the Middle East during Operation Desert Shield, we performed an epidemiologic survey.

## Materials and Methods

Between December 13, 1990, and January 7, 1991, two self-completed questionnaires were provided to all U.S. Navy personnel serving aboard the USNS *Mercy* T-AH 19. One questionnaire was a survey of diarrheal disease and the other a survey of respiratory disease. The number of participants completing both surveys represented approximately 83% of military personnel deployed aboard the ship at the time of the investigation. Most of those not completing the survey cited a lack of time or interest as the reason for non-participation.

Questions covered by the diarrhea survey included general demographic information, job description, location of workspace, messing facilities, berthing facilities, history of eating off the ship at foreign ports, and a description of gastrointestinal symptoms. For the purpose of the survey, diarrhea was defined as three or more loose or watery stools in a 24-hour period. Additional questions covered by the respiratory disease survey included a history of smoking, a history of respiratory disease, and a description of upper respiratory symptoms.

### Statistical Analysis

Mean values were compared using Student's *t* test; proportions were compared using the chi-square test with Yate's correction or Fisher's exact test. Multiple logistic regression analysis was performed using the SPSS/PC statistical package (SPSS Inc, Chicago, Illinois). For analysis of the diarrhea survey, logistic regression models were developed for the following outcome

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variables coded as present or absent: (1) any episode of diarrhea during deployment, (2) any episode of diarrhea with fever, (3) any episode of diarrhea with vomiting, and (4) inability to perform scheduled duties because of diarrhea. For the respiratory survey, multivariate models were developed for the following outcome variables: any episode during deployment of (1) pharyngitis, (2) cough, (3) cold-like symptoms with fever, and (4) rhinorrhea. All logistic models included independent variables for age, gender, and rank. Odds ratios (OR) were reported with 95% confidence intervals (95% CI). Confidence intervals were calculated with the use of logistic-regression parameter estimates and their standard errors for multivariate analysis. A two-tailed $p$ value of 0.05 was considered to indicate statistical significance.

## Results

There were 722 subjects (mean age 28.3 years; range 17–58 years) who completed the two questionnaires. Sixty-eight percent of subjects were men (mean age 28 years) and 32% women (mean age 29 years). Enlisted personnel made up the majority (77%) of participants. Women were much more likely to be officers (39%) than men (16%). The age, gender, and rank of subjects who did not participate in the survey were similar to the final study population.

### Diarrheal Disease Survey

At least one episode of diarrhea during deployment was reported by 46.3% of the surveyed population, with 27% experiencing two or more episodes of diarrhea. Diarrhea with accompanying fever was reported by 11.6% of subjects, and diarrhea with vomiting was reported by 6.2%. Gastrointestinal symptoms were severe enough to prompt a sick call visit by 7.6% of subjects, and 8.3% received medication. A higher percentage received medication than reported to sick call because doctors sometimes evaluated and prescribed medication to co-workers without an actual visit to sick call. Gastroenteritis was severe enough to temporarily prevent the performance of daily work duties by 6% of the total study population.

In univariate analysis, there was no association between the age of subjects and having an episode of diarrhea or an episode of diarrhea with fever; but subjects reporting diarrhea with vomiting tended to be younger (25.4 compared to 28.5 years, $p = 0.007$). A higher percentage of women reported an episode of diarrhea, an episode of diarrhea with vomiting, and time lost from normal duties due to symptoms of gastroenteritis (Table I). Officers were also more likely to report an episode of diarrhea.

By multivariate analysis with age, gender, and rank included in all models, an independent association was found between being an officer and an episode of diarrhea and inability to carry out routine duties (Table II). Also, an independent association was found between both younger age and female gender and an episode of diarrhea with vomiting.

An episode of diarrhea was reported in association with a port visit by 23.1% of subjects, with Bahrain, where subjects most often ate ashore, having the highest percentage of port-related diarrheal cases (15%). By multivariate analysis, subjects who ate in Bahrain had nearly a three times greater risk of developing diarrhea (OR 2.8) after adjusting for age, gender, and rank (Table II).

### Respiratory Disease Survey

Thirty-one percent of subjects reported that they were current smokers, and 5.8% reported a history of mild respiratory disease, either asthma or bronchitis. At least one upper respiratory complaint during deployment was reported by 78.7% of the surveyed population. Cold-like symptoms with fever were reported by 27.9%, cough by 53.2%, sore throat by 49.1%, and chronic rhinorrhea by 16.6%. Upper respiratory symptoms

**TABLE I**

MORBIDITY DUE TO DIARRHEAL DISEASE AMONG 722 U.S. NAVY PERSONNEL DEPLOYED ABOARD USNS *MERCY* T-AH 19 DURING OPERATION DESERT SHIELD

| | | Percent with Symptoms | | | | |
|---|---|---|---|---|---|---|
| | Number | Diarrhea | Diarrhea + Fever | Diarrhea + Vomiting | Sick Call Visit | Unable to Work |
| Total | 722 | 46.3 | 11.6 | 6.2 | 7.6 | 6.0 |
| Age (years) | —[a] | | | | | |
| 17–20 | 95 | 51.6 | 13.7 | 9.5 | 8.4 | 3.2 |
| 21–25 | 225 | 42.4 | 12.4 | 7.1 | 7.6 | 5.4 |
| 26–30 | 153 | 45.8 | 12.6 | 7.8 | 5.3 | 4.6 |
| ≥31 | 243 | 49.0 | 9.1 | 3.3 | 9.1 | 8.7 |
| Gender | | | | | | |
| Male | 490 | 44.1 | 10.6 | 4.3 | 6.7 | 4.7 |
| Female | 232 | 51.1[b] | 13.5 | 10.3[c] | 9.5 | 8.6[b] |
| Rank | | | | | | |
| Enlisted | 554 | 42.9 | 11.4 | 6.7 | 7.2 | 4.7 |
| Officer | 168 | 57.7[c] | 12.0 | 4.8 | 8.9 | 10.2[c] |

[a] Age data were missing for six subjects.
[b] $p$ value < 0.01.
[c] $p$ value < 0.05.

TABLE II

SIGNIFICANT INDEPENDENT VARIABLES BY MULTIVARIATE ANALYSIS WITH AGE, GENDER, AND RANK INCLUDED IN ALL MODELS

| Model, Significant Independent Variables | OR | 95% CI | *p* Value |
|---|---|---|---|
| Diarrheal disease | | | |
| Outcome variable = any episode of dirrhea | | | |
| Officer status | 1.9 | 1.2–2.9 | 0.004 |
| Eating in Bahrain | 2.8 | 1.3–6.0 | 0.009 |
| Outcome variable = diarrhea with vomiting | | | |
| Age (by year) | 0.9 | 0.88–0.98 | 0.006 |
| Female gender | 2.7 | 1.5–5.1 | 0.002 |
| Outcome variable = unable to carry out duties | | | |
| Officer status | 2.0 | 1.03–3.9 | 0.04 |
| Respiratory disease | | | |
| Outcome variable = cold-like symptoms with fever | | | |
| Female gender | 1.9 | 1.3–2.7 | <0.001 |
| History of respiratory disease | 2.8 | 1.5–5.4 | 0.001 |
| Outcome variable = unable to carry out duties | | | |
| Female gender | 2.9 | 1.6–5.4 | <0.001 |
| History of respiratory disease | 4.7 | 2.2–10.3 | <0.001 |

were severe enough to interfere with the duties of 7.4% of the personnel surveyed.

In univariate analysis, younger subjects and women tended to have more respiratory complaints (Table III). Respiratory symptoms more often interfered with the duties of officers than enlisted personnel. There was no significant association between the smoking status of subjects and respiratory complaints.

By multivariate analysis with age, gender, and rank included in all models, female gender and a history of respiratory disease were independently associated with cold-like symptoms accompanied by fever and losing duty time because of respiratory complaints (Table II). The locations of working, messing, and berthing facilities were not associated with respiratory complaints.

## Discussion

Diarrhea and respiratory symptoms were common problems among military personnel serving aboard USNS *Mercy* T-AH 19 during Operation Desert Shield, and these symptoms often interfered with routine duties. The risk of diarrheal disease in this population of shipboard personnel was lower than that reported for ground troops, but the risk of upper respiratory disease was higher.[10,11]

Most of the reported diarrheal disease was of acute onset, short duration, and often related to eating in a foreign port, suggesting an infectious etiology. However, because this was a questionnaire study, the precise etiology of diarrhea and respiratory symptoms could not be determined. A large proportion of diarrhea among ground troops stationed in Saudi Arabia during Desert Shield was caused by enterotoxigenic *Escherichia coli* and *Shigella*, with *Salmonella*, *Campylobacter*, and Norwalk virus less common causative agents.[10] Similar enteropathogens were probably also important causes of gastroenteritis among the shipboard population.

As in ground troops, most cases of diarrhea responded clinically to empiric treatment with either norfloxacin or ciprofloxacin, whether or not antimotility agents were used.[10] A few cases required intravenous fluids and hospitalization for severe dehydration.

Some of the food supplies aboard ship, including fruits, vegetables, and milk, were procured from nearby countries, which could explain the diarrhea cases occurring during the time periods between port visits. Previous outbreaks of diarrhea have been associated with contaminated produce, including an outbreak aboard a U.S. Navy ship which was caused by *Salmonella*.[9]

The frequent occurrence of diarrhea among ship's personnel affected their ability to function normally for brief periods, and crew members frequently required sick call visits and medication for gastroenteritis. Although diarrheal symptoms were mainly an inconvenience, their impact on the ability of personnel to perform vital duties could have been greater had the ship received a large number of casualties during the war with Iraq. Based on the predicted number of casualties expected to be transported to the ship for treatment during the ground campaign, most of the medical personnel would have been required to work daily shifts of 12–16 hours. Any illness among medical personnel in such a situation would have an important impact on the care rendered to casualties. Therefore, the possibility of diarrheal disease compromising the mission of a hospital ship needs to be considered and effective prophylactic and vaccination strategies developed.

The causes of respiratory disease in this shipboard population were less clear, although based on the nature and short duration of symptoms, infectious disease agents were probably a major cause. Other determinants possibly contributing to complaints of cough, sore throat, and rhinorrhea include environmental factors, such as recirculation of internal dust and fumes from engine operations. Because cigarette smoking within the spaces of the ship was allowed only in two small lounges, far removed from working areas and living quarters, the effect of passive smoking on the frequency of respiratory symptoms was thought to be low.

Respiratory symptoms tended to be mild but persistent among ship's personnel. A definite infectious outbreak with a large number of cases in a very short period was not identified during deployment. There were few cases of pneumonia or purulent bronchitis, and most respiratory infections consisted of cold-like symptoms and sore throat.

Although the overall size of the hospital ship was large, living quarters, messing facilities, and medical spaces occupy a relatively small area. The potential for spread of respiratory pathogens among the ship's crew and among hospitalized patients was therefore great. Berthing compartments were small, housing up to 120 people in one space. Working spaces, especially medical wards, were also small, necessitating close contact among personnel assigned to a particular space, as well as contact with patients admitted to the wards. Increased crowd-

TABLE III

MORBIDITY DUE TO RESPIRATORY DISEASE AMONG 722 U.S. NAVY PERSONNEL DEPLOYED ABOARD USNS MERCY T-AH 19 DURING OPERATION DESERT SHIELD

| | | Percent with Symptoms | | | | |
|---|---|---|---|---|---|---|
| | Number | Cough | Sore Throat | Rhinorrhea | Cold + Fever | Unable to Work |
| Total | 722 | 53.2 | 49.1 | 16.6 | 27.9 | 7.4 |
| Age (years) | —[a] | | | | | |
| 17–20 | 95 | 60.0 | 52.6 | 18.9 | 24.2 | 5.3 |
| 21–25 | 225 | 56.9 | 55.4 | 22.3 | 24.9 | 5.4 |
| 26–30 | 153 | 54.9 | 52.0 | 15.0 | 33.8 | 8.5 |
| ≥31 | 243 | 46.1 | 40.0 | 10.8 | 28.2 | 9.1 |
| Gender | | | | | | |
| Male | 490 | 46.7 | 43.9 | 13.6 | 23.3 | 4.3 |
| Female | 232 | 66.8[b] | 59.9[b] | 22.8[b] | 37.4[b] | 13.9[b] |
| Rank | | | | | | |
| Enlisted | 554 | 54.9 | 49.4 | 17.4 | 26.6 | 5.8 |
| Officer | 168 | 47.6 | 48.2 | 13.8 | 32.1 | 12.6[b] |

[a] Age data were missing for six subjects.
[b] $p$ value < 0.01.

ing among shipboard personnel may explain their greater respiratory morbidity compared to troops who were stationed in Saudi Arabia.[11]

It has been previously shown that ship size correlates with the incidence of medical illness among its personnel, with smaller ships demonstrating higher rates of illness, including respiratory disease.[12] Because of the relatively small living and working spaces aboard the hospital ship, diarrheal and respiratory illness were more consistent with those of a "small ship."

The impact of diarrhea and respiratory illness among shipboard personnel appeared to be greater among female than male personnel. Woman participating in the survey were more likely to report diarrhea or respiratory symptoms and were more likely to be unable to perform routine duties due to illness. The reason for this difference could not be determined, although some of the difference may have resulted from confounding due to a greater percentage of officers among female subjects. It is also possible that women were more likely to report symptoms to sick call personnel or that women who had diarrhea or respiratory illness were more likely to participate in the survey, although a majority of both men and women personnel aboard ship completed the questionnaires. Another possibility is that women were more often exposed to diarrheal and respiratory pathogens from patients because they were more closely involved in direct patient care activities.

In addition to gender differences, officers were more likely to report diarrhea and were more often unable to perform duties due to diarrhea than enlisted personnel. One explanation for this finding is the possibility that during visits to foreign ports officers more frequently ate in a wide variety of local restaurants, while enlisted personnel tended to eat at U.S. naval base dining facilities, where food supplies were monitored by the military.

In summary, diarrhea and respiratory illness were common among personnel serving aboard the hospital ship USNS *Mercy* T-AH 19 during Operations Desert Shield and Desert Storm. Because the ship's personnel were not called upon to perform in a prolonged mass casualty situation, the true impact of such illness on patient care was not appreciated. Efforts toward improved prevention of diarrhea and respiratory disease among deployed shipboard personnel are needed, particularly the development of vaccines to prevent diarrheal disease.

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